National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

ERA22FA207

AIRWORTHINESS

Group Chair's Factual Report

June 12, 2023

A. ACCIDENT

Location: Elba, New York
Date: April 26, 2022
Time: 1300 eastern daylight time
Helicopter: Bell 429, registration N507TJ

B. AIRWORTHINESS GROUP

Group Chair	Chihoon Shin National Transportation Safety Board Washington, District of Columbia
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C. SUMMARY

On April 26, 2022, about 1300 eastern daylight time, a Bell 429 helicopter, N507TJ, impacted terrain after an inflight breakup. The instructor pilot and company pilot were fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 instructional flight. A representative of the operator, Mercy Flight Inc., stated that the instructional flight was a flight review being conducted by the helicopter manufacturer's flight instructor with multiple flight reviews planned throughout the day. The accident flight was the second flight of the day.

From April 27-28, 2022, the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), with representatives from the Federal Aviation Administration (FAA), Bell, and the operator examined the wreckage at the accident site. The wreckage was subsequently recovered and transported to Anglin Aircraft

Recovery in Clayton, Delaware. On April 29, 2022, a NTSB helicopter investigator (the author of this report), the NTSB IIC, and representatives from the FAA, Bell, and Pratt and Whitney Canada examined the recovered wreckage. Flight data from the cockpit display units (DU) was recovered by the NTSB Recorders Laboratory in Washington, District of Columbia.[1]

D. DETAILS OF THE INVESTIGATION

1.0 Helicopter Information

1.1 Helicopter Description

The Bell 429 helicopter is type certificated under Federal Aviation Administration (FAA) type certificate data sheet (TCDS) No. R00003RD. The Bell 429 has a four-bladed main rotor that provides helicopter lift and thrust and a four-bladed tail rotor that provides directional control. The flight control system includes a dual hydraulic system and a three-axis autopilot (pitch, roll, and yaw), with the option for a fourth axis (collective). The helicopter is equipped with two Pratt and Whitney Canada PW207D2 turboshaft engines mounted behind the main transmission. The accident helicopter was equipped with a skid-type landing gear.

All left, right, up, and down orientations as well as clock positions referenced in this report are in the aft-looking-forward frame of reference unless otherwise specified.

1.2 Accident Helicopter History

The accident helicopter was serial number (S/N) 57332 and was manufactured in December 2017. The No. 1 engine was S/N BL0681 and the No. 2 engine was S/N BL0682. The last entry in the aircraft logbook was dated April 24, 2022, and reflected an aircraft total time (ATT) of 1,039.6 hours, a No. 1 engine total time (ETT) of 1,039.6 hours, and a No. 2 ETT of 1,039.6 hours.

2.0 Helicopter Wreckage Observations

2.1 Structures

2.1.1 Airframe Description

The Bell 429 helicopter airframe is composed of two primary structures, the fuselage and tail boom, that are composed of a mix of aluminum and composite parts. The fuselage contains the cockpit, cabin, baggage compartment, and an upper

[1] For the details of the recovered flight data, see the Recorder Specialist's Factual Report in the docket for this investigation.

section containing the main transmission, engines, and hydraulic system. The tail boom contains the tail boom frame, horizontal stabilizer (with finlets), the vertical stabilizer, and the tail rotor and its drive system. The fuel system is composed of multiple bladder-type cells located underneath the cabin floor.

2.1.2 Fuselage Wreckage Observations

At the accident site, the fuselage had impacted terrain and came to rest on its left side (**Figure 1**). The fuselage had crushed inwards and had fractured and separated into two large sections: 1) the upper section composed of the roof structure and the forward tail boom section and 2) the lower section composed of the floor structure and landing gear.

Figure 1. The fuselage at the accident site.

2.1.3 Tail Boom Wreckage Observations

The tail boom had fractured and separated into two sections with angled fracture lines consistent with main rotor blade contact. The forward tail boom section remained attached to the upper section of the fuselage (**Figure 2**). The aft tail boom section was composed of the vertical fin and the tail rotor and was found about 400 feet away from the fuselage (**Figure 3**). A section of the tail rotor drive shaft cover exhibited an impact mark consistent with main rotor blade contact.

The right horizontal stabilizer was whole but most of the leading edge slats (containing the “danger” decal) had separated except for on the outboard end

(**Figure 4**). The right horizontal stabilizer finlet remained attached and was whole. The left horizontal stabilizer was whole but all of its leading edge slats had separated. The leading edge of the left horizontal stabilizer exhibited an impact mark about midspan. The left horizontal stabilizer finlet remained attached and was whole.

Figure 2. The forward tail boom section, with the right side facing up.

Figure 3. The aft tail boom section at the accident site.

Figure 4. A reconstruction of the empennage showing the horizontal stabilizer, aft tail boom section, and a portion of the forward tail boom section.

2.2 Main Rotor System

2.2.1 System Overview

Power from each engine reduction gearbox is delivered to the main transmission via two KAflex-type engine-to-transmission drive shafts. The main transmission drives both the main rotor system, via the mast assembly, and the tail rotor drive system. The main transmission also drives the two hydraulic pumps for the Nos. 1 and 2 hydraulic systems. The main transmission is mounted to the fuselage via pylon assembles on the left and right side of the transmission housing. Each pylon assembly is composed of a beam (attached to the cabin roof), a vertical Liquid Inertia Vibration Eliminator (LIVE) mount, a pitch restraint spring, and a stop assembly.

The main rotor system is composed of the hub assembly, four blade assemblies, and rotating controls. The hub assembly is composed of two composite flexible beams (flexbeams) that are stacked. Each flexbeam supports two main rotor blades. Each end of a flexbeam, along with the upper and lower mount plate assemblies, supports the pitch horn and grip assembly, centrifugal force (CF) bearing, shear bearing, and elastomeric lead-lag dampers for each blade. Each main rotor blade is retained to their respective grip via two blade bolts.

The main rotor blades are composite in construction and are composed of a fiberglass C-shaped spar, a foam core afterbody, carbon fiber upper and lower skins, a nickel-cobalt abrasion strip, and a tip cap. The four main rotor blades and their associated components are identified by color and the shape of identification stickers adhered to each rotor blade, presented in the order of advancing rotation: 'blue' (diamond), 'orange' (square), 'red' (triangle), and 'green' (circle). Blade pitch control is achieved via pitch change links (PCL) connected between each blade's pitch horn and the rotating swashplate.

2.2.2 Main Rotor Wreckage Observations

All four main rotor blades had separated from the main rotor head and were found in the debris field between the tail boom and the fuselage. The span of all four blades were recovered and their leading edges were fairly straight along the entire span (**Figure 5**). The tip ends of all four blades exhibited impact marks. Substantial portions of the blade afterbody were not present on the 'orange', 'blue', and 'green' main rotor blades and their spars exhibited fractures with a broomstrawed appearance. The 'red' main rotor blade afterbody was generally whole and its leading edge did not exhibit significant fractures. On the lower surface of the 'blue' main rotor blade, an impact gouge was present, its location (about 89 inches from the inboard blade bolt) and size consistent with the antenna mounted immediately aft of the engine exhaust pipes (**Figure 6**).

Figure 5. The recovered main rotor blades. They were identified as (from left to right) 'orange', 'blue', 'green', and 'red'.

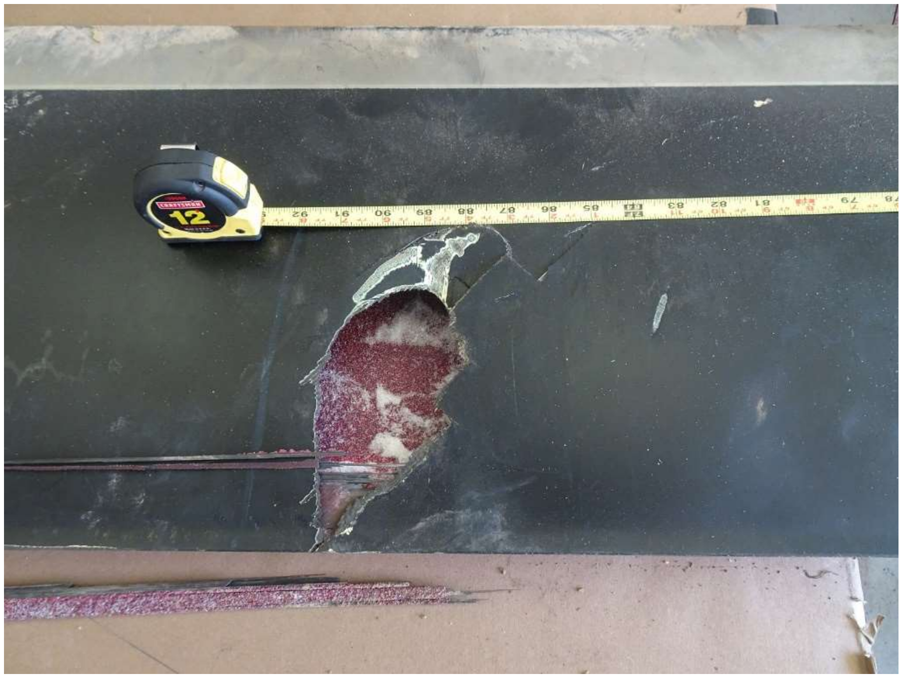

Figure 6. The impact gouge on the lower surface of the 'blue' main rotor blade.

On the main rotor head, three of the four yokes (each being an end of a flexbeam) had fractured and separated. The fourth yoke remained partially attached to the main rotor head. All four yokes contained the outboard portion of the CF bearing. The inboard portion of all four CF bearings remained attached to their respective pitch horn and grip assembly. The CF bearings exhibited differing degrees of deformation of its elastomeric layers. All lead-lag dampers remained attached, or partially attached as noted later in this paragraph, to the main rotor head and exhibited impact damage. The 'green' upper lead-lag damper was partially separated on its outboard side and its bolt heads were fractured and separated. On the 'red' upper lead-lag damper, the advancing-side bolt's head had fractured and separated.

2.2.3 Main Rotor Controls Wreckage Observations

The upper rod end of the 'blue', 'orange', 'red', and 'green' main rotor blade PCLs remained attached to its pitch horn but had fractured at their threaded connection to their respective PCL. The fracture on all four PCL upper rod end threads exhibited signatures of overload and was deformed in the inboard direction. The lower rod ends of all four PCLs remained attached to the rotating swashplate but had fractured features consistent with overload. Two PCL bodies, 'orange' and 'blue', were recovered. The 'orange' PCL exhibited slight deformation of the link body. The 'blue' PCL exhibited no significant deformation.

The swashplate assembly remained installed on the main rotor mast. The two rotating scissor link assemblies remained installed and attached between the rotating swashplate and the main rotor mast.

2.2.4 Main Rotor Drive System Wreckage Observations

The main gearbox remained partially attached to the airframe. The right longitudinal mount remained connected to the airframe and to its LIVE mount. The right pitch restraint was present but separated from the pitch restraint stop. The left longitudinal mount remained connected to the airframe and to its LIVE mount. The left pitch restraint was present but had separated from its pitch restraint stop. The left pitch restraint piston remained connected at both ends. The pitch restraint adapter was present but had separated from the main gearbox upper housing. The forward pitch restraint adapter had fractured at all four studs, with the upper stud nuts separating from their respective studs. All four studs exhibited signatures consistent with overload. The aft pitch restraint adapter remained attached to a separated portion of the main gearbox upper housing. The main gearbox lower housing exhibited localized fractures that exposed portions of the bevel gear.

The two input driveshafts remained connected to the main gearbox via the forward Kaflex coupling. The left input driveshaft had fractured aft of the forward Kaflex coupling. The right input driveshaft was whole but had partially separated near its forward end. Both input driveshafts could be manually rotated counterclockwise (freewheeling direction) but could not be manually rotated clockwise, likely due to restrictions within the main gearbox from impact damage.

2.3 Tail Rotor System

2.3.1 System Overview

Power from the main transmission is transferred to the tail rotor via the tail rotor drive system. The forward-most tail rotor drive shaft, connected to the main transmission, is a steel tail rotor drive shaft that is located beneath the engines. The steel tail rotor drive shaft is connected at its aft end to the fan blower shaft, the latter of which turns the oil cooler blower. Subsequent to the fan blower shaft, two composite tail rotor drive shafts, also known as the forward and aft segmented drive shafts, continue tail rotor drive to the tail rotor gearbox. A hanger bearing connects and aligns the two composite drive shafts. A snubber, used to limit the deflection of each shaft, is located about mid-length of each composite drive shaft. The tail rotor gearbox changes the direction of drive and reduces the input drive speed. The tail rotor gearbox output shaft drives the tail rotor hub assembly.

The tail rotor is composed of the hub assembly, four tail rotor blades, and its rotating controls. The hub assembly is composed of two stacked yokes, each yoke retaining a tail rotor blade at each end. The two yokes are offset about 70° to result in a scissored tail rotor configuration. Each tail rotor blade is composite in construction with a nickel abrasion strip. The four tail rotor blades are identified by color and the shape of identification stickers adhered to each rotor blade, presented in the order of advancing rotation: 'blue' (diamond), 'orange' (square), 'red' (triangle), and 'green' (circle). Blade pitch control is achieved via PCLs connected between each blade's pitch horn and the tail rotor crosshead.

2.3.2 Tail Rotor Wreckage Observations

The tail rotor remained installed on the tail rotor gearbox, which itself remained installed on the [separated] empennage. The four tail rotor blades where whole and did not exhibit significant fractures or fragmentation. The tail rotor input control was manually actuated and a corresponding change of pitch for all four tail rotor blades was observed. The tail rotor pitch control tube had fractured forward of the tail rotor gearbox and exhibited multiple fractures through its normal routing through the tail boom. The tail rotor servo actuator and stability and control augmentation system (SCAS) actuator remained installed and connected to the tail rotor pitch control tube.

2.3.3 Tail Rotor Drive System Wreckage Observations

The forward [steel] tail rotor drive shaft remained connected to the main gearbox but had fractured about midway to the fan blower shaft. The fan blower remained installed on the airframe. The forward segmented drive shaft remained attached to the fan blower shaft and was continuous through the forward snubber but had fractured near its connection to the aft segmented drive shaft and the hanger bearing; the hanger bearing was not present. The aft segmented drive shaft had fractured near its forward end and at the tail gearbox input flange. A portion of the aft snubber remained attached to its snubber mount.

The tail rotor gearbox remained installed on the empennage. Manual rotation of the tail rotor gearbox input flange resulted in a corresponding rotation of the tail rotor. The rotation was smooth with no evidence of binding or restriction.

2.4 Flight Control System

2.4.1 System Overview

The cockpit flight control system is composed of cyclic, collective, and directional (pedal) controls. The mechanical linkages for the left and right cockpit controls are interconnected laterally underneath the cockpit floor and routed to the mixer bellcranks. The cyclic and collective control linkages are routed up the right side of the cockpit, then to the three main rotor [hydraulic] servo actuators mounted in front of the main transmission. The lateral servo actuator (left position) and longitudinal servo actuator (right position) transmit their outputs to the main rotor stationary swashplate. The collective servo actuator (center position) transmits its output to the collective lever, which moves the swashplate assembly up and down.

The directional control inputs from the pedal are transmitted through a series of control tubes and a push-pull control cable (Teleflex-type) to the tail rotor [hydraulic] servo actuator, located at the aft end of the fuselage. The tail rotor servo actuator transmits its output to the tail rotor crosshead via push-pull tubes and bellcranks.

The cyclic pitch and roll dual SCAS actuators are located forward of the main rotor servo actuators and the directional control SCAS actuator is located forward of the tail rotor servo actuator. Pitch, roll, and yaw trim actuators, located underneath the cockpit floor, provide feedback loads and, in conjunction with the autopilot, can input cyclic and pedal commands to control the helicopter.

The dual hydraulic system, identified as Nos. 1 and 2, is composed of two separate, independent hydraulic systems to assist in moving the flight controls. Each hydraulic system is composed of a hydraulic pump, integrated hydraulic module (IHM), and hoses and tubes that provide hydraulic power to the four flight control servo actuators. Each IHM contains a reservoir, filter, pressure indicators, and valves. The No. 1 IHM is located on the left of the three main rotor servo actuators and the No. 2 IHM is located to the right.

2.4.2 Flight Control System Wreckage Observations

The cyclic and collective push-pull tubes, routed up the right side of the cockpit frame, were cut during recovery of the helicopter. With the exception of this cut, the longitudinal push-pull tube was continuous to the forward [of the two] pitch SCAS actuator. The control tube between the two pitch SCAS actuators was present but had fractured on both ends with signatures of overload. The aft [of the two] pitch SCAS actuator remained connected to the longitudinal servo actuator. The longitudinal servo actuator's aft support had fractured and separated from its support structure, but its attachment hardware was present (**Figure 7**). The control tube between the longitudinal support bellcrank and the stationary swashplate was not present, but its rod end remained connected to the stationary swashplate.


Figure 7. The three main rotor servo actuators.

With the exception of the aforementioned cut, the collective push-pull tube was continuous through the forward bellcrank up to the collective servo actuator. The collective servo actuator's aft support remained attached to the support structure, but the support structure had fracture features consistent with overload. Control continuity was established between the collective servo actuator and the collective lever.

With the exception of the aforementioned cut, the lateral cyclic push-pull tube was continuous to the forward bellcrank, to which the forward [of the two] roll SCAS actuators was attached. The control tube between the two roll SCAS actuators remained connected to the forward roll SCAS actuator but had fracture features consistent with overload and separated from the aft roll SCAS actuator. The aft roll SCAS actuator remained connected to the lateral servo actuator input, but the input housing of the lateral servo actuator had fractured and separated from the actuator. The lateral cyclic servo actuator remained connected to the support structure. The control tube between the lateral support bellcrank remained installed but the control tube was bent inward.

The Nos. 1 and 2 IHM were present and partially attached to the wreckage via hydraulic lines. The Nos. 1 and 2 hydraulic pump had separated from the main gearbox but remained attached to their respective IHMs via hydraulic lines.

2.5 Engines

2.5.1 Engine Overview

The Pratt and Whitney Canada PW207D1 is a turboshaft engine that comprises a single-stage centrifugal compressor, a reverse flow annular combustion chamber, a single stage compressor turbine, driven by the centrifugal compressor, and a single stage power turbine (free turbine). The power turbine delivers power to a reduction gearbox that subsequently drives the helicopters rotor transmission and drive system. Each engine incorporates an electronic engine control (EEC) that commands the fuel management module when the engine fuel control is in the automatic (primary) mode. Each engine's fuel management module can be manually manipulated (manual/backup mode) via its twist grip on the collective control.

2.5.2 Engine Wreckage Observations

The No. 1 engine was partially attached to the airframe via hoses and was whole. The first stage compressor blades did not exhibit damage except for one blade that was bent in the direction of normal rotation, with a series of indentations on its leading edge. The power turbine blades visible through the engine exhaust did not exhibit anomalous damage or deformation, and all blades were present.

The No. 2 engine was partially attached to the airframe via hoses but had fractured into two halves. The first stage compressor blades exhibited impact damage and gouges on their leading edges. Scrapes were present on the inner housing of the first stage compressor blades in line with the blade tip path. The power turbine blades visible through the engine exhaust did not exhibit anomalous damage or deformation, and all blades were present.

The No. 1 EEC remained installed on the airframe and its wire bundle remained connected. The No. 2 EEC's airframe mounts had fractured and deformed, but the EEC was retained within the airframe via its [still connected] wire bundle. Both engine data collection units (DCU) were present but exhibited impact damage. Both engine DCUs remained connected to their wiring plugs. The Nos. 1 and 2 engine EECs and DCUs were removed and retained for data recovery.

3.0 Engine DCU Download

From May-July 2022, attempts were made to recover data stored within the engine EECs and DCUs, initially at Pratt and Whitney Canada facilities in Quebec, Canada, and subsequently at the Transportation Safety Board of Canada laboratory in Quebec, Canada. Ultimately, no data could be recovered from the No. 1 engine EEC and DCU due to impact damage. However, data was able to be recovered from the No. 2 engine EEC and DCU. The recovered data showed two event codes: 1) code

1006 or power turbine speed (NPT) peak value and 2) a final entry of code 1002 or an unexpected flameout. No faults were recorded with these events. Analysis by Pratt and Whitney Canada of the data associated with the NPT peak value event concluded these occurrences during flight are normal and occurred about 1 hour and 24 minutes prior to the accident. Similar analysis of the unexpected flameout code concluded the event code was logged during a normal engine shutdown on the ground, with no faults or exceedances recorded during the accident flight.

4.0 Maintenance

The last annual inspection of the accident helicopter was accomplished on November 29, 2021, at an ATT of 956.1 hours under Mercy Flight work order No. 1549. A 1-month inspection was performed on April 1, 2022 at an ATT of 1,023.4 hours per Bell 429 Maintenance Manual task No. DMC-429-A-05-40-00-28A-281A-A. Within the accident helicopter's flight and maintenance log, the last maintenance entry was dated April 20, 2022, which stated that the Garmin [navigation] databases were updated.

Submitted by:

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